Potassium chloride: absorption and excretion

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Summary: The absorption of potassium chloride in liquid form has been studied, using urinary excretion as an index of absorption. The excretion of potassium chloride was observed after inducing a water diuresis and administering a single dose in liquid form. There is evidence that potassium chloride in liquid form is absorbed rapidly, probably from the stomach, and hence there is a good rationale for its use where rapid absorption is needed, as in digitalis intoxication.

Résumé: *Le chlorure de potassium: son absorption et son excrétion.*

Nous avons étudié l'absorption du chlorure de potassium administré sous forme liquide et l'avons évaluée en nous basant sur son excrétion urinaire. Nous avons observé l'excrétion du chlorure de potassium après avoir déclenché une diurèse hydrique et avoir administré le produit sous forme liquide. Des preuves existent que le chlorure de potassium sous forme liquide est absorbé rapidement, probablement à partir de l'estomac. D'où nous concluons qu'il serait logique de l'utiliser sous cette forme, dans les cas où s'impose une absorption rapide, notamment dans l'intoxication digitalique.

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Patients with potassium-wasting disorders, and those taking medication that causes potassium loss, frequently need a greater potassium intake than is available in the normal diet and hence require potassium supplements. Potassium salts are also frequently used in the management of digitalis intoxication. Although there is no question of the clinical usefulness of potassium chloride, there is considerable disagreement among practitioners as to which mode of administration provides the best results. In an emergency situation the intravenous route is recommended and is the obvious choice, if possible. Occasionally, however, it is impossible or impractical to use intravenous potassium and one resorts to oral administration in the hope of achieving rapid absorption. Patients with digitalis intoxication whose arrhythmias are not life-threatening may be treated in this manner if circumstances make hospital admission and intravenous therapy impractical.

How effective, then, is potassium chloride when administered by mouth, from the point of view of rapidity of absorption? The present study was undertaken with this question in mind.

Many commercial preparations of potassium chloride are available, including liquids, and enteric-coated and effervescent tablets. Although it seems quite likely that absorption of enteric-coated tablets is satisfactory[1-5] there is ample evidence that these tablets may produce intestinal ulceration, possibly complicated by hemorrhage, perforation and peritonitis.[6,7] Subsequent stenosis and obstruction have also been reported. Clearly, potassium salts taken in liquid form are advantageous, at least from the point of view of avoidance of these complications. Since their absorption may be erratic and slow, it would seem unwise to attempt treatment of arrhythmias with enteric-coated tablets of potassium salts.

For circumstances in which the treatment of arrhythmias or the correction of serious hypokalemia is to be accomplished by orally administered potassium salts, it is desirable to have more information on the rate of absorption of the liquid form.

Method

The primary assumption made in this study is that, if body stores of potassium are not depleted, there should be a rapid increase in urinary potassium excretion after the drug is absorbed from the gastrointestinal tract. Subjects chosen for this investigation had to fulfil the following conditions: they should not have been taking potassium-wasting drugs, such as thiazide diuretics, or potassium supplements; their serum electrolytes should be within normal limits; and they must not have congestive heart failure, renal disease or aldosteronism due to any cause because of the potassium-wasting effect of aldosterone.

The 12 subjects, who were taking a normal diet (which included a potassium intake of about 80 mEq. per day), fasted from after their evening meal on the day before the test until early morning. They were awakened at 5:00 a.m. and voided, discarding the urine. At that time, and every hour thereafter, the subjects drank water, emptied the bladder and measured the urine volume. At 5:00 after voiding, they drank 300 ml. of water; at 6:00 and every hour thereafter they drank 200 ml. only, as close as possible to the hour. A water diuresis was established to ensure an adequate hourly volume of urine for accurate measurement of potassium excretion. Urinary electrolytes were estimated using an IL 143 flame photometer. No meals were given during the day and the test was terminated at 6:00 p.m. Multiplication of the volume of urine by the potassium concentration yielded the excretion of potassium in each hour.

After several hours, when a stable continuing water diuresis had been established, usually at 11:00, a single dose of 24 mEq. of potassium was administered in liquid form. The preparation used in all cases was two effervescent tablets which dissolved quickly in water.

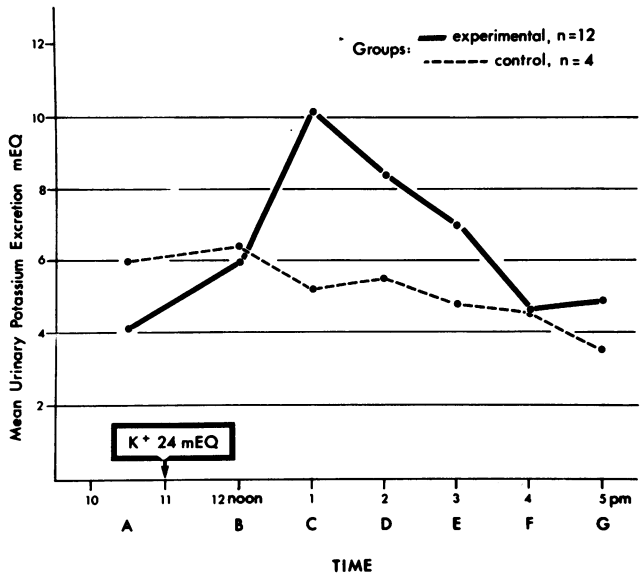

FIG. 1—Average values of hourly potassium excretion of experimental and control subjects.

Table I
Urinary potassium excretion (mEq.) at timed intervals in subjects receiving the potassium preparation and in controls

	Urinary K+ (mEq.)						
Patient no.	A	B	C	D	E	F	G
K+ administered							
1	3.68	7.35	9.60	8.00	6.60	5.40	5.25
2	1.35	2.55	5.25	2.80	2.55	1.90	1.80
3	6.04	2.80	14.00	11.00	14.00	9.45	11.60
4	4.55	6.29	8.29	11.96	4.68	2.57	5.40
5	2.62	5.95	13.20	9.76	11.30	8.90	9.06
6	4.66	4.90	10.85	9.25	7.70	4.32	3.19
7	2.98	4.20	10.50	10.40	6.60	3.25	1.75
8	4.37	6.00	8.25	9.45	8.40	4.14	4.60
9	7.74	9.66	14.49	11.76	7.95	5.70	7.44
10	4.91	10.75	13.05	7.20	4.99	4.02	3.57
11	3.02	8.36	9.24	5.76	4.68	3.42	2.98
12	2.81	2.98	5.18	4.55	4.30	3.85	2.00
Mean	4.06	5.98	10.16	8.49	6.98	4.74	4.89
Controls							
1	7.66	6.20	7.20	6.46	6.50	6.08	2.40
2	4.05	4.50	3.50	4.00	3.85	3.85	3.58
3	5.40	5.50	3.60	5.50	2.60	2.20	3.60
4	5.88	9.03	6.65	6.25	6.08	6.80	4.50
Mean	6.00	6.31	5.24	5.55	4.76	4.73	3.52

Each tablet provided 12 mEq. of potassium and 8 mEq. Each tablet provided 12 mEq. of potassium and 8 mEq. of chloride (Potassium-Sandoz®).

The same procedure was followed by four subjects who were not given potassium chloride, to observe the effect of water diuresis alone on potassium excretion.

Results

In all 12 cases where potassium was given, there was a prompt rise in urinary potassium excretion, usually seen in the specimen voided one hour after administration of the salt, and peaking at two hours after administration (Table I). Increments of this order were not seen in any of the controls. The average values for hourly potassium excretion for both experimental and control groups are plotted in Fig. 1. Comparisons of the potassium values for the 12 experimental subjects and the four controls were carried out, taking into account the matched pairing in the design. Comparisons were made between the baseline value (column A) and each of the values in columns B to G (Table I), which represent the values at each hourly interval following potassium administration. Column A represents the average of the values for the two hours prior to administration of the drug. The comparison between the baseline and the various hourly-interval values was made by obtaining a "Z" score, based upon the standard error of the differences between matched pairs. The comparison for the 12 experimental patients yielded in all cases a "Z" score greater than 2.60 (Table II). A

Table II
Comparison of baseline potassium values (A) with those at timed intervals (B to G)
References

Comparisons	"Z" score (significant "Z" is 2.60)	
Experimental group		
A : B	4.64	
A : C	9.10	
A : D	7.26	All significant at the 1% level
A : E	3.52	
A : F	3.14	
A : G	2.82	
Control group		
A : B	2.21	
A : C	0.21	
A : D	0.19	None significant at the 1% level
A : E	2.21	
A : F	1.74	
A : G	2.46	

"Z" score above this figure indicates a significant difference at the 1% level. It was also noted that the most significant difference between the baseline value and subsequent hourly values was at two hours after taking the drug.

In the four subjects who received no potassium supplement, a slight decrease in urinary excretion of potassium, possibly related to the water diuresis, was seen and hence none of the computed "Z" scores met the 2.60 level (Table II).

Clearly, in the 12 individuals in the experimental group, the only explanation for the rapid increase in potassium excretion is that the potassium chloride ingested must have been rapidly absorbed.

Discussion

There was a striking difference in potassium excretion between the controls and those who received potassium chloride (Fig. 1). Since at the first hour after administration an abrupt increase in urinary potassium excretion was demonstrated, it is quite likely that the absorption of liquid potassium chloride took place in the stomach. Presumably the peak absorption took place near the end of the first hour since the maximum excretion of potassium was in the second hour after the dose was given. The renal handling of potassium chloride seems to occur almost immediately after absorption from the gastrointestinal tract in the presence of a water diuresis. These findings do not necessarily apply to the non-fasting patient in the absence of a water diuresis, which is the usual situation in which potassium supplements are used in clinical practice. This will be the subject of future investigation.

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